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A mixing barrel assembly (100) has a screw-flight (118) provided with a resilient wear resistant coating (91) along at least its free edge portion. The coating may cover the entire internal surface of the barrel assembly (100) which may be of conventional metal form or it may utilise a screw-flight (118) formed of a reinforced plastics material. The barrel may also be formed of a reinforced plastics material.

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"IMPROVEMENTS TO MIXING BARRELS"

-- BACKGROUND OF THE INVENTION --

This invention relates to mixing barrels and parts and apparatus therefore.

5 This invention has particular reference to transport barrels for mobile concrete mixers and more particularly to transport barrels for pre-mixed concrete trucks which are formed predominately of composite plastics materials. For illustrative purposes only, reference will be made
10 hereinafter to such application. However the application of this invention is not limited to concrete mixing barrels but may be used for barrels for other processing or storage applications.

Pre-mixed concrete delivery trucks are widely used in
15 the pre-mixed concrete industry for delivering mixed concrete to work sites. The transport barrel is provided with one or more internal screw-flights and is rotated in one direction during transport providing continuous mixing of the concrete mix and which acts as screw conveying means when the barrel
20 is rotated in the opposite direction for discharging the concrete mix therein on site.

Typically the mixing barrels are fabricated from steel and due to the abrasive nature of the concrete mix their internal surfaces wear rapidly in use causing such mixing
25 barrels to have a relatively short operational life. The cost of replacing such mixing barrels contributes significantly to the cost of delivering the pre-mixed concrete.

High wear occurs over the screw-flight and particularly
30 along its exposed inner edge. Thus attempts have been made in the past to reduce maintenance on the screw-flight by incorporating a bead along its inner edge in the form of a deformed bar or flat bar welded on to the free inner edge of the screw-flight. While these measures are effective in
35 prolonging the life of the screw-flight, such beads are costly to install and do not prolong the interval between

flight and/or barrel replacements to such extent that they provide significant cost benefits.

In addition the weight of the screw-flight alone is typically about four hundred kilograms and thus the weight of 5 such steel barrels contributes significantly to the load carried by the transporting vehicle. If this weight could be reduced the payload carried by the vehicle could be similarly increased with a potential for significant increases in economy of transport of pre-mixed concrete. The provision of 10 a welded bead along the free inner edge of the flight in the form of a deformed bar or inner edge of the flight in the form of a deformed bar or flat bar further increases the weight of the screw-flight.

-- SUMMARY OF THE INVENTION --

15 The present invention aims to alleviate at least one of the abovementioned disadvantages and in one aspect aims to provide a method of and/or products or apparatus for enhancing the wear characteristics of mixing barrels which will be reliable and efficient in use. In a further aspect 20 this invention aims to provide enhanced mixing barrels provided with an abrasion resistant internal surface. In yet a further aspect this invention aims to provide improvements to mixing barrels which will alleviate at least one of the abovementioned disadvantages.

25 With the foregoing in view, this invention in one aspect resides broadly in a mixing barrel assembly having a screw-flight provided with a resilient wear resistant coating along the free edge portion of the screw-flight. The resilient wear resistant coating is suitably formed of a synthetic 30 plastics material such as a wear or abrasion resistant polymeric compound and is suitably formed to a thickness of between 3mm and 10mm. The free edge portion of the screw-flight may include an integral bulbous edging about which the coating is applied or the coating itself may be formed as a 35 bulbous termination along the free edge of the screw-flight. In a preferred form the coated free edge is of bulbous form

and has an overall diameter of between 20mm and 40mm. The coating is preferably a polyurethane coating formulated to provide a Shore A hardness rating of between 60 and 95.

The coating may comprise a two part self curing
5 polyurethane system or a one part moisture cure polyurethane system if suitable. For example, the coating may be selected from a prepolymer of a difunctional isocyanate with a polyalkylene glycol having a residual NCO functionality, mixed prior to application with an amine cross linking agent.
10 Typical prepolymers include the 80/20 reaction product of toluene diisocyanate (TDI) with a polypropylene glycol (PPG), or diphenylmethane diisocyanate (MDI) and PPG, having a residual NCO functionality of about 4-6% in each case.

The crosslinking agent may be selected from any of the
15 known amine crosslinking agents commonly used for curing polyurethane prepolymers. For example, the crosslinking agent may comprise an aromatic amine such as di (methylthio) toluenediamine. For the aforementioned prepolymer systems having residual NCO functionality, such a crosslinking agent
20 may be employed in an amount of about 9-13% by weight.

The resilient wear resistant coating may be applied as moulded edging strip which is fitted over the free edge portion of the screw-flight, which may be formed of steel in conventional manner or be formed of composite plastics
25 material, and mechanically fastened thereto. Preferably the mechanical fastening means is achieved by bolting with bolts formed of a resilient wear resistant material which is substantially the same as that which forms the coating. However any suitable type of replaceable mechanical fastening
30 means such as metal bolts may be used if desired.

Alternatively, the moulded edging strip may be bonded to the free edge portion of the screw-flight.

In a preferred embodiment of the invention the resilient wear resistant coating is applied to the free edge portion of
35 the screw-flight in the form of a settable paste-like compound which sets to form the resilient wear resisting

coating. The paste-like compound may be applied in one or more passes to achieve the desired thickness which is suitably in the order of 3mm to 5mm adjacent the bulbous portion. The coating may bond to the free edge portion of the screw-flight or it may be secured thereto by extending through apertures formed in the free edge portion.

In order to provide a permanent bond between the coating which has been applied by extruding and the free edge portion so that the coating is operatively supported, it is preferred that a steel free edge portion is prepared by shot blasting, cleaning and priming prior to the addition of the resilient wear resistant coating.

In a preferred embodiment of the invention the entire internal surface of the barrel and the screw-flight is coated with a wear resistant polymeric coating which is suitably applied by a spraying process to a substantially constant thickness about the barrel surface and the screw-flight. Preferably the polymeric coating applied to the entire surface is compatible with or substantially identical to the coating applied to the free edge portion of the screw-flight.

Subsequently the paste-like compound applied to the free edge to build up the desired thickness is applied such that it bonds to the previously applied coating. This provides a homogeneous coating which is thickest about the free edge of the screw-flight where the wear is greatest. A moulded strip or the like may also be applied by bonding or mechanical fastening to the coated barrel. Suitably the wear resistant compound deposited on the screw-flight edge is harder than the wear resistant compound deposited on the internal barrel surface. The hardness of the coating may vary between a Shore A hardness rating of between 60 and 95.

In a preferred embodiment the wear resistant polymeric coating is also applied as a fillet at abrupt changes in section, such as at the junction between the flight and the barrel wall and the barrel wall and the dished end wall. In addition in instances where the flight has a mounting flange

welded along one side to the barrel, a fillet is applied at the junction between the flange edge and the barrel to form a smooth transition at the junction. The fillet material is suitably the same compound as that applied to the free edge of the flight.

In order to ensure complete bonding of the coating to the barrel and flight surfaces, it is preferred that they are prepared by sand blasting and subsequent cleaning, suitably achieved by forced air cleaning using clean dry air to remove all loose residue in the barrel and washing with a solvent such as acetone. The cleaned surface is then coated with a water resistant priming adhesive which may be applied in one or more passes. After the primer has cured it is dusted and the wear resistant coating is applied. This procedure ensures that an effective bond is achieved between the coating and the barrel and flight surfaces such that delamination of the coating from the barrel will be substantially alleviated in use.

The coating and primer may be spray applied in any suitable manner. However it is preferred that the application of the spray coating be machine applied so that a relatively constant thickness coating is achieved. For this purpose it is preferred that spraying apparatus be provided having a spray head assembly which moves in a controlled spiral path relative to the barrel and adjacent the barrel surface and substantially conforming with the screw-flight.

Suitably the spray head incorporates a plurality of spray nozzles including nozzles directed at the barrel surface and nozzles directed at the screw-flight surface, and preferably the opposed surfaces, of the screw-flight. The spray head may extend to both sides of the screw-flight for simultaneous coating of the opposite sides of the flight. Alternatively it may span the pitch of the flight to simultaneously coat opposed flight portions. If desired each side of the flight may be coated in a separate pass.

It is also preferred that the spray head be controlled

for radial translation relative to the barrel axis in order to maintain a substantially constant proximity to the frusto-conical barrel surfaces. The above processes may also be used if the coating is to be applied to the screw-flight
5 only.

In a further aspect this invention resides broadly in an applicator assembly for applying a coating to the inside surface of barrel provided with an internal screw-flight including:-

10 a spray head assembly for spraying a liquid to be applied to the internal surfaces of the barrel and/or screw-flight;

supply means for supplying the liquid to be applied to the spray head assembly, and

15 support means for supporting the spray head assembly internally of the barrel for axial and rotational movement relative to the barrel.

The support means may support the barrel for movement relative to the spray head but preferably the barrel is
20 supported fixedly and the support means includes a supporting stem which may be extended into and retracted from the barrel and having a radially extendible support arm at its free end supporting the spray head assembly. The relative extensions/retractions of the stem and support arm
25 may be controlled by electronic means or they may be interconnected for automatic relative movement thereof.

However in a preferred embodiment the stem is controlled for extension and/or retraction at a substantially constant speed and the support arm is biased to its extended position
30 and is provided with abutment means thereon which prevents extension of the support arm beyond a position at which the spray head is at its operative spacing from the barrel surface or screw-flight.

It is also preferred that the stem be supported co-
35 axially with the barrel and that it be simultaneously advanced and rotated whereby the spray head maintains a

substantially constant relationship with the screw-flight.

In a further aspect, this invention resides broadly in a coated screw-flight section for a mixing barrel, which may be a steel barrel or a barrel formed from composite materials, 5 the coated screw-flight section including a composite screw-flight structure formed of reinforced plastics material and a resilient wear resistant coating covering the portion of the screw-flight structure which is exposed in use to abrasion by the process materials. Preferably the coating is formed of a 10 synthetic plastics material such as a wear or abrasion resistant polymeric compound and is formed, such as by spraying, to a thickness between 3mm and 10mm to each side of the screw-flight structure.

It is also preferred that the coating of the composite 15 screw-flight structure and thickening about its edge portion be as optionally described above with reference to a conventional screw-flight.

In a preferred embodiment of the invention, the screw-flight assembly is formed from sections of about 1.5m to 2m 20 in length which are overlapped at their joints and fastened together by fastenings formed from a wear resistant polymeric compound such as a polyurethane material. After the fastenings have been secured, they are covered with a paste-like compound which bonds to the fastenings and the wear 25 resisting coating. The paste-like compound may be applied in one or more passes to achieve the desired smooth transition across joins and forms a continuation of the wear resistant coating.

The flight sections may also be formed with a flange 30 along their outer edges adapted to conform to the internal surface of the barrel at contact zones therein and suitably this flange is bonded and fastened to the barrel with a coating and fastenings formed of the wear resisting material or other materials if desired and subsequently treated to 35 remove abrupt section changes through exposed edges and fastening heads. Preferably the fastenings are formed as

bolts for simplicity of application.

Alternatively, the structural core portions of the screw-flight sections may be exposed at their ends to be joined and bonded in end abutting relationship through reinforced plastics material laminated across the joint between flight sections. The exposed ends of adjoining sections may be tapered and spaced apart to enable the laminated reinforced plastics to be laminated across the joint and to substantially the same thickness without thickening the flight assembly at the joint between flight sections, whereafter the resilient wear resistant coating may be applied over the exposed surfaces to form a continuation of the coating applied to the section.

If desired the outer edge of the flight sections may be bonded to the barrel surface by laminations of fibreglass reinforced materials applied in-situ, in addition to or instead of the bolted flanged connections. Suitably the wear resistant polymeric coating is also applied to form a fillet at abrupt changes in section, such as at the junction between the flight and the barrel wall and over the fastenings.

In order to ensure effective bonding of the fillets to the coatings on the surfaces of the flight, such as at joins between sections or to fair in section changes, the base coating may be treated by cleaning with a solvent such as acetone. The cleaned surface may then be coated with a primer which may be applied in one or more passes. Suitably the primer is dusted after the primer has cured and the wear resistant fillet material is applied.

The flight sections may be suitably formed with high strength reinforcing material such as KEVLAR and/or carbon fibre and possibly with a 40/60 mix thereof such as in a crows foot weave and in layers of 600gsm to build up to a thickness of between 3mm and 5mm and used to reinforce a plastics material such as epoxy resin, polyester resin or vinylester resin. Alternatively a 1200gsm multi directional fibreglass reinforcement may be used for the plastics

material.

After curing such structures are primed with a thickened bonding adhesive/primer which is water resistant and which is allowed to dry for a period of six to eight hours before a
5 second coat of adhesive/primer is applied. This is allowed to cure for about ten hours and is then dusted whereupon the resilient wear resistant coating is applied, suitably in two laminations each in the order of 1mm to 2mm thick such that a minimum thickness coating is achieved of at least 2mm.

10 In a preferred embodiment of the invention flight parts are formed in moulds providing a coated base wall and a coated top wall which are bonded together to form a flight section to be bolted to the barrel. Preferably the base and top walls are laminated in respective complementary female
15 moulds suitably using epoxy resin and vacuum forming techniques to consolidate a solid laminate of epoxy resin reinforced with fibreglass cloth or woven rovings. However conventional laminating techniques may be utilised if desired. A similarly moulded core member may be interposed
20 between the base and top walls if desired. The core member which is preferably open form, lattice like, honeycomb or of egg-crate form, may be laid up to approximately the same specifications as the top and base wall mouldings, or utilise chopped strand matt as the reinforcing material. The core
25 member would have one moulded face which engages flush against the non-moulded face of the bottom wall and an opposed face which engages flush against the non-moulded face of the top wall so that the three parts may be laid one upon the other and bonded together using the same or a compatible
30 resin suitably thickened for its purpose.

In the presently preferred embodiment it is envisaged that the moulds for the top and base walls will each be provided with peripheral flanges which are complementary and either the upper or lower mould or both will be formed with a
35 well or channel around the inside of its peripheral flange. This arrangements enables a resilient seal to be placed

between the peripheral flanges of the moulds and a vacuum applied to the channel so as to pull one mould evenly down onto the other mould.

In use this is to be performed with the moulded walls
5 remaining in their respective moulds and engaged over the moulded core so that effective bonding between the walls and the moulded core may be achieved.

In yet another aspect of this invention the mixing barrel assembly is formed from composite plastics sections
10 and preferably sections that can be released from one-piece moulds and including a tapered barrel shaped base section having a dished end wall section closing its smaller open end, and a tapered barrel shaped nose section converging from said tapered barrel shaped base section. Preferably the
15 mating ends of the tapered barrel shaped nose and base sections are formed with mating external flanges which are mechanically fastened together such as by bolting.

The dished end wall section may be formed separately and integrated with the tapered barrel shaped base section by
20 laminations of the composite materials from which the dished end wall section and the tapered barrel shaped base section are separately formed. Preferably however the dished end wall section is formed integrally with the tapered barrel shaped base section.

25 In a preferred embodiment of this invention the dished end wall section, the base section and the nose section are laminated from axially oriented glass cloths or laminates reinforcing epoxy resin. It is also preferred that the nose section be moulded with an outwardly projecting annular rib
30 intermediate its open ends for supporting a metal track ring and that the rib be formed with an outer cylindrical wall portion and be reinforced with additional layers of laminates to spread working loads from the track ring into the barrel section.

35 Furthermore it is preferred that the internal recess formed by the rib be filled with the wear resistant coating

about the exposed portions of fasteners, or heads thereof, securing the ring to the barrel section and extending into the barrel section. Similarly it is preferred that the dished end wall section be reinforced with additional
5 laminates to provide a secure mounting for a drive ring fastened centrally and externally thereto.

The integrated end wall and base section and the nose section may be coated prior to being fastened together and prior to fastening the respective screw-flight sections
10 thereto. Alternatively the integrated end wall and base section and the nose section may be moulded about a male mould and have the resilient wear resistant coating applied on the mould. An internal recess for location of the outer edge of the flight internal recess for location of the outer edge of
15 the flight sections may also be formed in the base section and the nose section to facilitate accurate location of the flight sections therein.

Preferably the barrel sections are vacuum formed between male and female moulds wherein the male mould is formed from
20 a modified reinforced polymer which provides it with sufficient elasticity that it may expand under the influence of the applied vacuum to compress the uncured epoxy laminate against the female mould. If desired the wear resistant coating may be applied to the male mould prior to addition of
25 the uncured epoxy laminates or reinforcing to the male mould for subsequent support within the female mould and compression or consolidation therebetween. The female mould may be provided with an external finish coat or if desired the finishing coat may be applied after formation of the
30 moulding such as by spray painting with a polyurethane paint or the like.

Alternatively, the resilient wear resistant coating may be applied over the internal surface of the moulded and assembled structure in the form of a paste-like compound
35 which bonds to reinforced plastics structure and sets to form the resilient wear resisting coating. The paste-like

compound may be applied in one or more passes to achieve the desired thickness which is suitably in the order of 3mm.

In a preferred embodiment the invention, the screw-flight assembly is formed from sections of about 1.5m to 2m 5 in length which are overlapped at their joints and fastened together by fastenings formed from a wear resistant polymeric compound such as a polyurethane material. Suitably the screw-flight assembly is pre coated with wear resistant material and bolted in place over the wear resistant coated 10 surface of the barrel assembly. Additional wear resistant material may be applied, such as by trowling, about the joint lines between the barrel assembly and the screw-flight assembly and over any bolt heads which may be recessed to provide minimum discontinuities in the internal surface of 15 the barrel and a smooth transition across joins. The paste-like compound which cures or sets to form the wear resistant coating may be applied in one or more passes to achieve the desired thickness coating.

Alternatively the outer edge of the flight sections may 20 be bonded to the barrel surface by laminations of fibreglass reinforced materials applied in-situ, in addition to or instead of the bolted flanged connections.

In still a further aspect this invention resides broadly in a mixing barrel for pre-mixed concrete delivery trucks 25 having a barrel assembly and a screw flight formed from composite materials as optionally defined above and an internal surface coated with a wear resistant material as optionally defined above.

-- BRIEF DESCRIPTION OF THE DRAWINGS --

30 In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a typical embodiments of the invention, wherein:-

FIG. 1 is a diagrammatic illustration of a preferred 35 form of applicator assembly for applying coating to the inside surface of a mixing barrel;

FIG. 2 illustrates an alternate method of protecting the free edge portion of a screw-flight;

FIG. 3 illustrates a preferred form of the liquid supply means for supplying the spray head;

5 FIG. 4 illustrates one form of flight section;

FIG. 5 illustrates a typical flight lamination;

FIG. 6 illustrates one form of core moulding;

FIGS. 7 and 8 illustrate alternate forms of flight sections;

10 FIG. 9 is a cross-sectional view of a typical moulding arrangement;

FIGS. 10 and 11 illustrate a hopper and swivel chute which may be formed in a similar manner as the flight sections;

15 FIG. 12 is a side view of a mixing barrel according to the present invention;

FIG. 13 is a sectional view of the mixing barrel of Fig. 12;

20 FIG. 14 is an enlarged sectional view of the encircled area 14 in Fig. 13;

FIGS. 15 is an enlarged sectional view of the encircled area 15 in Fig. 13, and

FIG. 16 is an enlarged sectional view of the encircled area 16 in Fig. 13.

25 -- DESCRIPTION OF THE PREFERRED EMBODIMENT --

The applicator assembly 10 illustrated in Fig. 1 is adapted for applying a wear resistant polymeric compound to the inside surfaces of a mixing barrel which is formed from a series of interconnected frusto-conical sections 12 and
30 provided with an internal screw-flight illustrated diagrammatically by the dotted line 13. The width of the screw-flight 13 measured inwardly from the barrel inner surface is substantially constant, however the distance of its innermost free edge portion 14 varies with the diameter
35 of the barrel assembly 11.

The polymeric compound urethane coating may be spray

applied by a plurality of spray heads 15 mounted on the arm 16 and an opposing arm, not illustrated, whereby the spray heads straddle the screw-flight 13. The spray heads 15 include sprays directed towards the screw-flight 13 and may include sprays directed towards the inner surface of the barrel assembly 11. Alternatively separate spray head assemblies for coating the inside of the barrel and for coating the screw-flight may be used in separate passes. Similarly respective passes of the spray head with one arm 16 only may be used to coat respective opposed sides of the screw-flight. The sprays are arranged to provide a substantially constant thickness coating to those surfaces. The arm 16 and nozzles 15 form part of a spray head assembly 17 which is supported at the end of a radially extending telescopic support arm 18 supported internally of the barrel 11 by the cantilevered stem assembly 20.

The telescopic support arm 18 is biased to an extended position and is provided with a guide roller 21 at its outer end which is adapted to bear upon the innermost edge of the screw-flight 13 for the purposes of maintaining a substantially constant relationship between the spray heads 15 and the internal surfaces of the barrel assembly 11 to be coated.

The cantilevered stem assembly 20 includes a beam 23 supported at its rear end on a lower rail 24 by a lower roller assembly 25 and a further roller assembly 26 associated with a post 27 fixed to the rail 24. The post 27 carries an idler sprocket 28 which is associated with a drive chain 29 anchored to the leg 30 which extends down from the beam 23 to the roller assembly 25. A drive sprocket 32, located at the same level as the idler sprocket 28, co-operates with the chain 29 such that it may be rotated to advance or retract the supporting beam 23 relative to the rail 24.

The beam 23 provides bearing mounts 34 for an axle 33 which extends from the telescopic supporting stem assembly 20

through the bearing mounts 34 to a rearmost position at which the axle 33 is chain driven by a further motor and sprocket assembly 35. Liquid is carried to the spray heads 15 from liquid supply means 38 through a flexible line 39 which is
5 preferably supported on contra-rotating drums at each end of the spray head assembly 17 as illustrated in Fig 3. Alternatively liquid may be supplied through a hollow axle 33 to the spray nozzles and through a rotatable banjo type fitting 31 on the outer end of the axle 33 as illustrated in
10 Fig. 1.

In the embodiment illustrated in Fig. 2, a screw-flight 40 has its inner edge protected by a flexible wear resistant strip shown in cross-section in Fig. A and B. In the embodiment illustrated in Fig. 2A the strip 41 is a flexible
15 polyurethane strip having a bulbous protective portion 42 which extends about the beaded edge 43 and connecting leg portions 46 which straddle the flight 40. The strip 41 is bolted to the flight at regular intervals by the bolts 44 and nuts 45 which are also formed from a wear resistant
20 polyurethane material.

The strip 50 illustrated in Fig. 2B is similar however the outer edges of the legs 51 are tapered and it is bonded to the flight 40 which may be plain and prepared for bonding in the manner describe above or coated with a wear resistant
25 coating as described above.

Referring to Fig. 3 it will be seen that the axle 33 supports drums 60 and 61 at respective ends and rotatable with the axle 33 and about which the opposite ends of the supply line 39 and its extension 63 is coiled. The line 39
30 intermediate the drums 60/61 is held parallel to the axle 33 such that as the beam 23 extends, the line 39 is uncoiled from the front drum 60 and retracted towards the rear drum 61 by the line extension 63 winding thereon. This extension 63 is connected to the supply line 39 by a tension spring 64 to
35 allow for variations in the relative movements of the supply line 39 and extension 63 onto and from their respective

drums.

This maintains the supply line 39 without loose portions which could rub on coated edges causing damage to the coating or the line which would wear and eventually rupture. As the
5 line 39 is operated at high pressure such rupturing may be dangerous.

Suitably the spray head rotates about 2.5 turns to follow the screw-flight and each drum 60/61 supports enough hose such that a full coil remains at the extremities of
10 movement. In addition the front drum 60 is sufficiently small, about 300mm diameter to fit through the barrel opening. The line 39 and extension 63 intermediate the drums 60 and 61 passes over transition pulleys 65 for travel parallel to the axle 33.

15 The liquid supply means 38, the motor and sprocket assembly 35 and the drive means for the sprocket 32 are controlled by a microprocessor 66 such that the stem assembly 20 may advance into a barrel with the axle 33 rotating so as to maintain the guide roller 21 in constant engagement with
20 the inner edge of the screw-flight 13. The axle 33 is set up substantially co-axial with the barrel assembly 11 such that extension of the telescopic support arm varies progressively in accordance with the overall diameter of the barrel 11.

By using the applicator assembly 10 the inside surface
25 of a barrel assembly 11 including the screw-flight 13 may be coated with a spray-on coating of substantially uniform thickness in a procedure which is machine controlled for consistent quality.

In a preferred embodiment and in preparation for
30 application of the wear resistant coating, the inside surface of the barrel is first shot blasted to an ASA class 2.5 finish and is then cleaned with an air blast using clean dry air. The inside surface is then washed down with a solvent. The surface is then primed with an adhesive which is a water
35 resistant which is allowed to dry for a period of six to eight hours before a second coat of adhesive/primer is

applied. This is allowed to cure for about ten hours and is then dusted whereupon a wear resistant polyurethane coating is applied in two passes with an hour pause between passes and with each pass depositing a coat in the order of 1.5mm thick.

This coating is allowed to cure for about eight hours whereafter a build-up of a hardness modified polyurethane material is extruded onto the free inner edge of the screw-flight using a suitably shaped extruding tool such that a beaded edge is formed having a dimension of between 20mm and 40mm.

Referring to Figs. 4 to 11 it will be seen that the structural core of each flight section 70 is suitably laminated in three moulds utilising the preferred Kevlar/carbon fibre composite or fibreglass woven material and epoxy resin. One of the mould is used to form the lattice-like core 71 as illustrated in Fig. 6 and the other moulds 72 and 74 are used to form the opposed walls and fit snugly one within the other as illustrated in Fig. 9. Each female moulds is formed as a part spiral section of a length of 1.5m - 2m. The wall moulds 72 and 74 have a returned flange portion 76 along their outer edges which is adapted to form the outer flange 77 which abuts the inner face of a mixing barrel 73 and is bolted thereto by bolts 75 faired in with a paste formed from the wear resistant material.

The moulds 72/74 have congruent peripheral flanges 78 therearound between which a resilient seal 79 is placed and the bottom mould 72 has a channel 80 thereabout formed with an air extraction outlet 81 so that air may be evacuated from the mated moulds to draw them together. This is done after the moulded walls have cured and the moulded core has been removed from the mould and placed in position between the walls with a suitable thickened epoxy bonding agent on its mating faces. Evacuation ensures effective bonding of the walls to the core on all mating surfaces.

Typically each wall is laminated in the respective mould

72/74 using vacuum forming techniques in epoxy resin reinforced with a layer of tri-axial cloth of 1200 gsm. The prepared mould is first coated with the wear resistant material to a suitable thickness of about 3mm and before it 5 has fully cured the epoxy laminate is vacuum formed thereon.

If desired a primer may be applied to the cured or partially cured wear resistant material prior to laminating the epoxy resin or the laminated wear resistant material may be sanded or cleaned with a solvent prior to further 10 laminating.

The preferred primer is an adhesive which is water resistant and filled with talc or synthetic lightweight filler or the like which is allowed to dry for a period of six to eight hours before a second coat of adhesive/primer is 15 applied.

After both walls have been moulded and cured and the core has been moulded and removed from the mould, the core is prepared for bonding by sanding or suitable cleaning or etching and placed in the base of the mould 72 with epoxy 20 adhesive on its contact faces and on the mating faces of the walls formed in the moulds 72/74. The opposing mould 74 is then nested into the mould 72 with a resilient seal 79 inserted between the perimeter flanges 78. Air is then evacuated through the connection 81 to pull the moulds 25 together about the core ensuring effective bonding together of the walls and core. This state is maintained until the epoxy adhesive has set. The vacuum is then released and a release fluid such as water or air is injected into the moulds 72/74 through the inlets 89 to release the moulds from 30 formed coated flight section.

In this embodiment the wear resistant coating is a polyurethane coating formulated to provide a Shore A hardness of about 80 and built up in laminations of about 1.5mm to provide a 3mm thick lamination across the surface of the 35 flight.

After the flight section 70 has been removed from the

moulds a preformed strip 82 of wear resistant material is bonded to the flight edge 83 and through bolted thereto with bolts 84 also formed of the wear resistant material. This arrangement is illustrated in Fig. 7. In the embodiment 5 illustrated in Fig. 8 the outer edges 85 of the opposed moulded walls of the flight are spaced apart and the bulbous edge 86 is formed by trowling the thickened wear resistant material into the space 87 therebetween and so as to protrude beyond their edges.

10 Referring to Fig. 5 it will be seen that the reinforced plastic screw-flight section 70 has an inner structural core 71 of about 12mm thickness, reinforced epoxy laminates 90 at each side thereof and resilient wear resistant polyurethane coating 91 as described above formed to a thickness of 3mm at 15 each side.

It is considered that this will provide a screw-flight which is about one quarter the weight of a conventional steel screw-flight which will represent a weight saving in the order of 300 kg in a conventional concrete mixing barrel.

20 Thus the payload of pre-mixed concrete, without increasing the vehicle load, may be increased by 300 kg without making any modifications other than the substitution of the screw-flight of the present invention for the conventional steel screw-flight.

25 If desired a flight section may be formed in which the inner edge is returned upon itself upon as an open C-section configuration to provide a round base for the thickened coating along the inner edge of the flight. Depending upon the application of the flight, a simple returned flange 30 formed with a significant corner radius may also be utilised to provide the bulbous edge which is advanced into the processed material.

Alternatively, the bulbous edge may be formed from adhesive and filler shaped in-situ to provide an enlarged 35 bead along the inner edge of the laminated flight for subsequent covering by the wear resistant coating.

The hopper 92 and discharge chute 93 illustrated in Figs. 70 & 71 may be formed in a similar manner to further reduce weight. As illustrated the pivot mounts 94 of the discharge chute 93 are formed in a steel sub-frame 95 bonded 5 to the moulded shell 96. Furthermore, the flight sections of the present invention may be utilised with a mixing barrel which is also formed from composite plastics materials such as those used to form the flight sections.

The mixing barrel assembly 100 is moulded in separate 10 front and rear sections 101 and 102 respectively, bolted together by abutting complementary flanges 103 which form external collars about the large open ends of the sections 101 and 102. These sections 101 and 102 taper inwardly from the collars 103 so that they may be moulded in a tapered one 15 piece female mould and removed therefrom.

The front section 101 has a steel track ring 106 bolted and bonded to a narrow cylindrical mounting section 107 formed in the wall thereof intermediate its ends, as illustrated in Fig. 106. It will be seen that the 20 cylindrical section 107 extends rearwardly from an outwardly extending flange 108 to its junction with the frusto-conical body section 110. This provides an arrangement in which the moulded barrel with integral mounting section 107 may be released from a female mould within which it is formed.

25 The cylindrical mounting section 107 provides a stable mounting for a track ring 106 which, if desired, may be formed as a shrink fit onto the cylindrical mounting section 107. It will also be seen that the through bolts which bolt the track ring 106 to the cylindrical mounting section 107 30 are countersunk with the retaining nuts substantially concealed within the recess 111 formed behind the flange 108. This provides an arrangement whereby the recess 111 containing the may be filled with wear resistant material to form a substantially continuous inner surface through the 35 mixing barrel.

It will also be seen from the part sectional views that

the fibre reinforcement is built up to become progressively thicker and stiffer adjacent the mounting section 107 so that point loads applied to the ring 106 may be distributed more evenly to the remaining body of the mixing barrel. Similar
5 thickening occurs at the flanged ends of the front and rear sections 101 and 102, as illustrated in Fig. 15, and at the central portion of the dished end wall 109 to which the drive ring 115 is attached by through bolting as illustrated in Fig. 14.

10 In the present embodiment the front and rear barrel sections are built up using three layers of 1200gsm fibreglass reinforcement with five additional layers, lapped in a staggered fashion, being added about the flanges 103. The bolt reinforcing washers 116 are suitably built up of
15 similar thickness material as the flanges 103 as is the barrel adjacent the cylindrical mounting section 107. The flat central portion 116 of the dished end wall 109 has numerous layers of the 1200gsm reinforcement which tapers to fewer layers of the 1200gsm at the curved section 118. An
20 additional similar number of layers of the 1200gsm reinforcement is applied to reinforce the drive ring mounting portion to which the drive ring 115 is attached by through bolted.

Referring specifically to Fig. 15, it will be seen that
25 tapered frusto-conical washers 116 are provided on each side of the flanged connection at each bolted joint to more effectively distribute the bolting loads to the thickened flanges 103. However an alternate form of reinforcing, utilising external stiffening steel rings may be used if
30 desired. In such application the connecting bolts would pass through the steel rings at the remote sides of the joined flanges.

Suitably the barrel sections 101 and 102 are vacuum formed as one piece epoxy resin mouldings which are bolted
35 together to form the barrel 100. Subsequently the screw-flight 118 which is diagrammatically illustrated in Fig. 17

and which is moulded of a cored fibreglass reinforced material suitably using epoxy resin, is through bolted through its peripheral flange 119 to the side wall of the mixing barrel assembly 100. The flange 119 is suitably
5 bonded to the internal surface of the mixing barrel in addition to being bolted and all internal surfaces of the mixing barrel and the screw-flight are covered with a wear resistant coating suitably as variously described above to suit the application. A thickened flange 42 extends along
10 the inner edge of the screw-flight 118.

It is believed that a mixing barrel assembly made according to this embodiment will have sufficient strength for prolonged use in the pre-mixed concrete industry and provide weight saving advantages over steel barrels which
15 will make it more economical to transport pre-mixed concrete to sites.

It will of course be realised that the above has been given only by way of illustrative example of the invention and that all such modifications and variations thereto as
20 would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as is herein set forth.

It will of course be realised that the above has been given only by way of illustrative example of the invention
25 and that all such modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as is defined in the appended claims.

-- CLAIMS --

1. A mixing barrel assembly having a screw-flight provided with a resilient wear resistant coating along the free edge portion of the screw-flight.
- 5 2. A mixing barrel assembly as claimed in claim 1, wherein the resilient wear resistant coating is an abrasion resistant polymeric compound.
3. A mixing barrel assembly as claimed in claim 2 and adapted for pre-mixed concrete, wherein wear resistant
10 coating includes a bulbous edging of generally part circular form and having an overall diameter of between 20mm and 40mm.
4. A mixing barrel assembly as claimed in claim 3, wherein the resilient wear resistant coating is a resilient abrasion resistant coating applied to the free edge portion
15 of the screw-flight in the form of a settable paste-like compound which sets to form the resilient wear resisting coating.
5. A mixing barrel assembly as claimed in any one of the preceding claims, wherein the resilient wear resistant
20 coating deposited on the screw-flight edge is harder than the wear resistant coating deposited on the internal barrel surface.
6. A mixing barrel assembly as claimed in any one of the preceding claims, wherein the resilient wear resistant
25 coating is a polyurethane coating formulated to provide a Shore A hardness rating of between 60 and 95.
7. A mixing barrel assembly as claimed in any one of the preceding claims, wherein the screw-flight is formed of composite reinforced plastics materials and having a

resilient wear resistant coating covering the portion of the screw-flight structure which is exposed to abrasion.

8. A mixing barrel assembly as claimed in claim 7, wherein the resilient wear resistant coating is formed to a thickness between 3mm and 5mm to each side of the screw-flight structure.
9. A mixing barrel assembly as claimed in claim 7 or claim 8 and adapted for pre-mixed concrete, wherein the screw-flight assembly is formed from sections of about 1.5m to 2m long.
10. A mixing barrel assembly as claimed in any one of claims 7 to 9, wherein the screw-flight section is formed with a flange along its outer edges adapted to conform to the internal surface of the barrel.
11. A mixing barrel assembly as claimed in any one of claims 7 to 10, wherein the screw flight is reinforced with high strength reinforcing material.
12. A mixing barrel assembly as claimed in any one of claims 7 to 11, wherein the screw flight includes a moulded base wall, a core member and a moulded top wall which are bonded together.
13. A mixing barrel assembly as claimed in claim 12, wherein the base and top walls are laminated in respective complementary female moulds suitably using epoxy resin and vacuum forming techniques to consolidate a solid laminate of epoxy resin reinforced with fibreglass cloth or woven rovings.
14. A mixing barrel assembly as claimed in claim 12 or claim 13, the core member is of open form, lattice like, honeycomb

or of egg-crate form, and laid up to approximately the same specifications as the top and base wall mouldings and has one face which engages flush against the non-moulded face of the bottom wall and an opposed face which engages flush against
5 the non-moulded face of the top wall whereby the three parts may be laid one upon the other and bonded together.

15. A mixing barrel assembly as claimed in claim 14, wherein the moulds for the top and base walls are each provided with peripheral flanges which are complementary and providing a
10 well or channel around the inside of the joined peripheral flange to accommodate a resilient seal.

16. A mixing barrel assembly having assembly formed from composite plastics sections including a tapered barrel shaped base section having a dished end wall section closing its
15 smaller open end, and a tapered barrel shaped nose section converging from said tapered barrel shaped base section.

17. A mixing barrel assembly as claimed in claim 16, wherein the mating ends of the tapered barrel shaped nose and base sections are formed with mating external flanges which are
20 mechanically fastened together.

18. A mixing barrel assembly as claimed in claim 16 or claim 17, wherein the tapered barrel shaped base section and the tapered barrel shaped nose section are formed from composite plastics sections that can be released from one-piece moulds.

25 19. A mixing barrel assembly as claimed in claim 18, wherein the base section and the nose section are laminated from axially oriented glass cloths or laminates reinforcing epoxy resin.

20. A mixing barrel assembly as claimed in any one of claims
30 16 to 19, wherein the nose section is moulded with an

outwardly projecting annular rib intermediate its open ends formed with an outer cylindrical wall portion which is reinforced with additional layers of laminates to spread working loads into the barrel section.

5 21. A mixing barrel assembly as claimed in any one of claims 16 to 20, wherein the barrel sections are vacuum formed between male and female moulds, wherein the male mould is formed from a modified reinforced polymer which provides it with sufficient elasticity that it may expand under the
10 influence of the applied vacuum to compress the uncured epoxy laminate against the female mould.

22. A mixing barrel assembly as claimed in any one of claims 16 to 21, wherein the wear resistant coating is applied to the male mould prior to addition of the uncured epoxy
15 laminates or reinforcing to the male mould for subsequent support within the female mould and compression or consolidation therebetween.

23. A mixing barrel for pre-mixed concrete delivery trucks having a barrel assembly as claimed in any one of claims 16
20 to 22, a screw flight as claimed in any one of claims 7 to 16 and an internal surface coated with a wear resistant material as claimed in any one of claims 1 to 6.

24. A method of forming a barrel for a pre-mix concrete delivery vehicle, including:-
25 preparing a free edge portion of the screw flight by shot blasting, cleaning and priming prior to the addition of a resilient wear resistant coating as defined in any one of claims 1 to 6.

25. A method of forming a barrel for a pre-mix concrete
30 delivery vehicle as claimed in claim 24, including coating the invention the entire internal surface of the barrel and

the screw-flight with a wear resistant polymeric coating as claimed in any one of claims 1 to 6.

26. A method of forming a barrel for a pre-mix concrete delivery vehicle wherein the entire internal surface of the barrel and the screw-flight are coated with a wear resistant polymeric coating and including:-

preparing the surfaces by sand blasting and subsequent cleaning using clean dry air to remove all loose residue in the barrel;

10 washing the surfaces with a solvent;

coating the surfaces with a water resistant priming adhesive, which is allowed to cured, and

dusting the primed surface and coating with a wear resistant coating.

15 27. A method of forming a barrel for a pre-mix concrete delivery vehicle as claimed in claim 26 and including applying the wear resistant coating material to a substantially constant thickness of between 3mm and 8mm.

28. Spraying apparatus having a spray head assembly for
20 spraying the wear resistant polymeric coating and which moves in a controlled spiral path relative to the barrel and adjacent the barrel surface and substantially conforming with the screw-flight.

29. Spraying apparatus as claimed in claim 28, wherein:-
25 the spray head incorporates a plurality of spray nozzles including nozzles directed at the barrel surface and nozzles directed at the screw-flight surface, and
the spray head is controlled for radial translation relative to the barrel axis in order to maintain a
30 substantially constant proximity to the frusto conical barrel surfaces.

30. A barrel assembly for a pre-mix concrete delivery vehicle substantially as hereinbefore described with reference to the accompanying drawings.

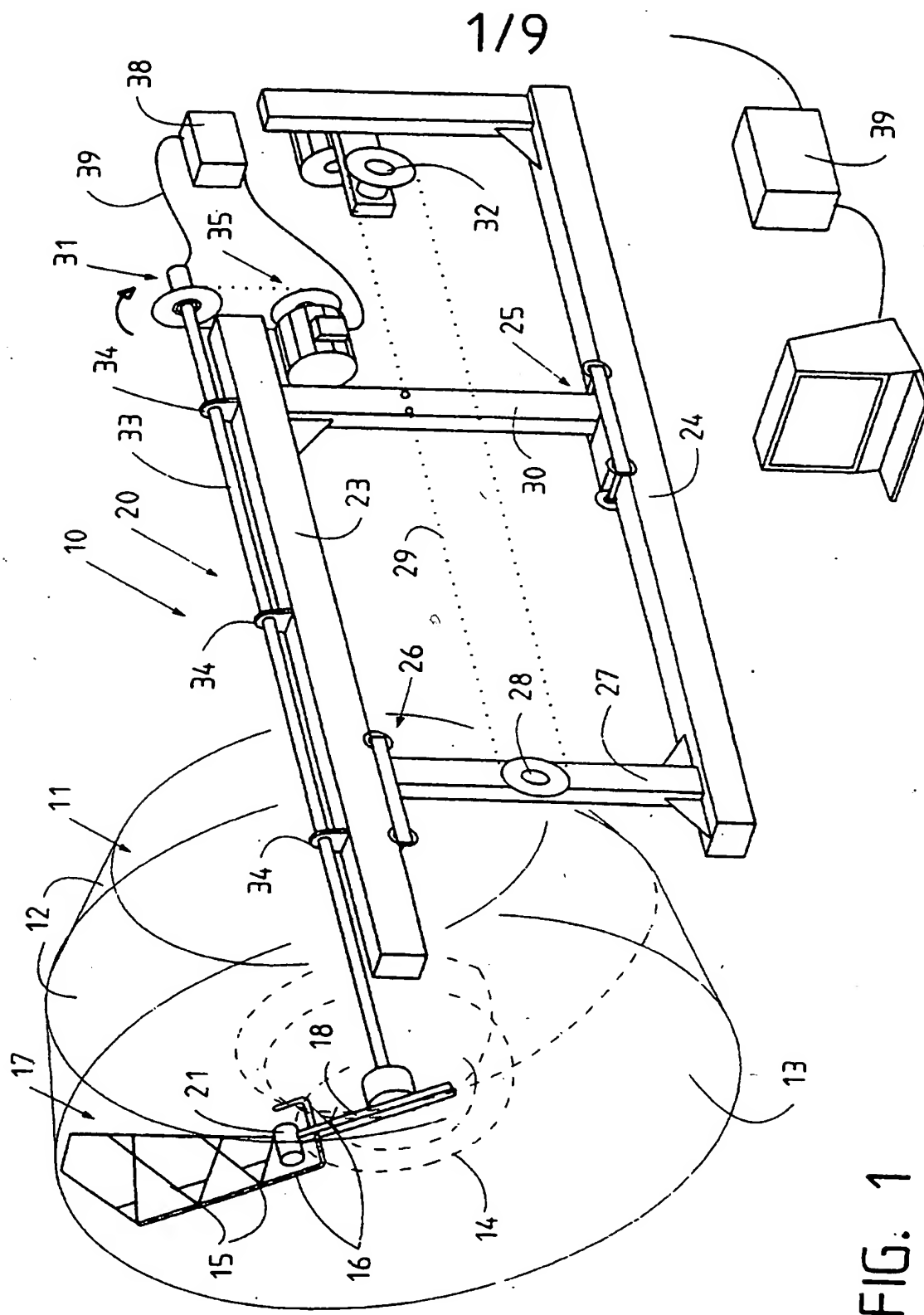
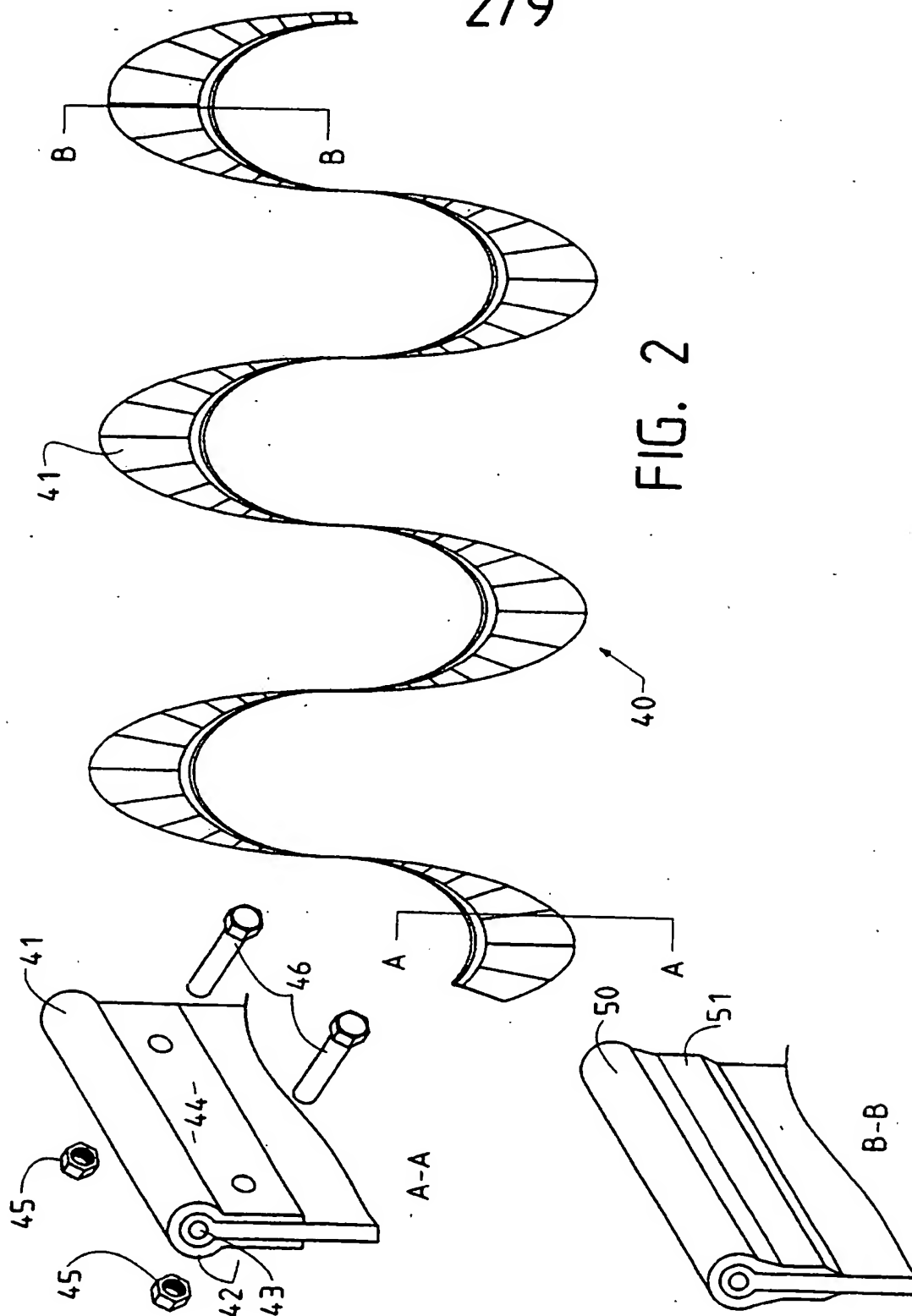


Fig. 1

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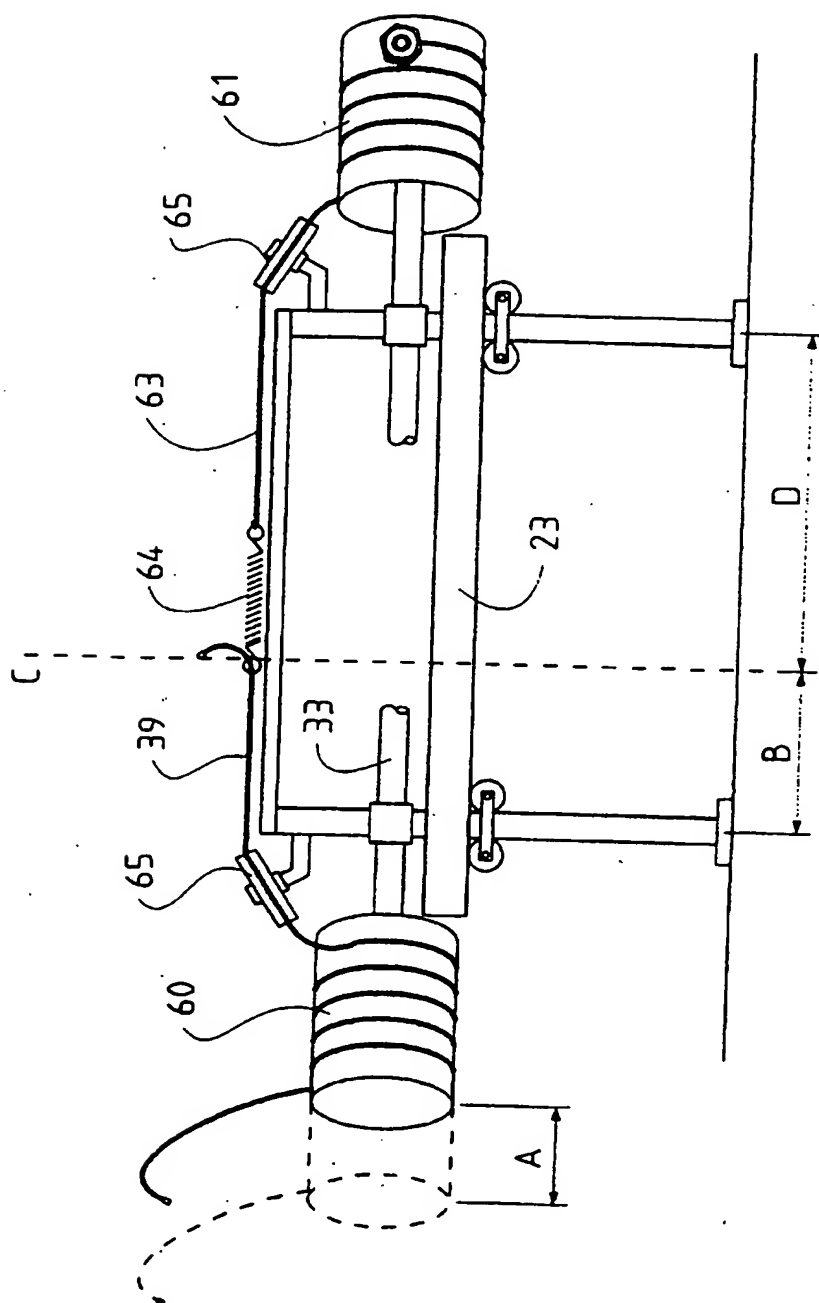


FIG. 3

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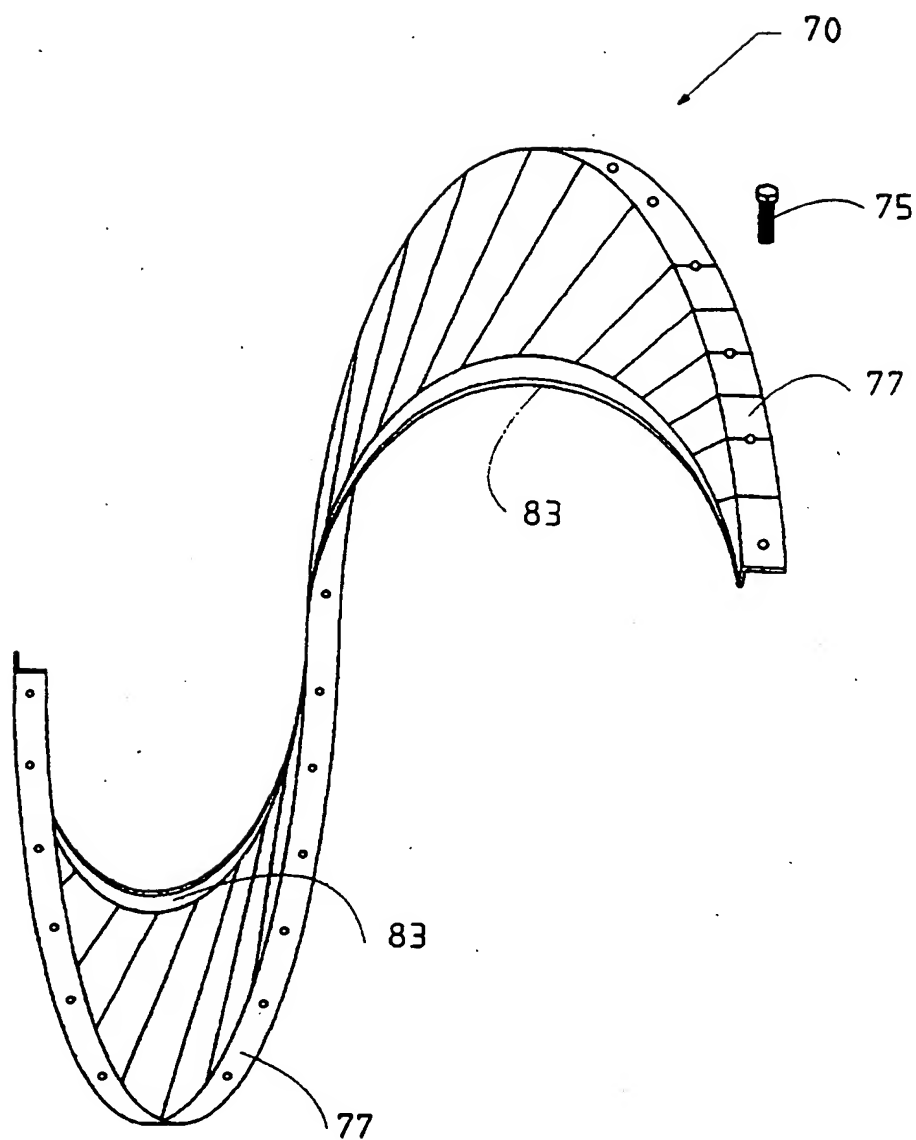


FIG. 4

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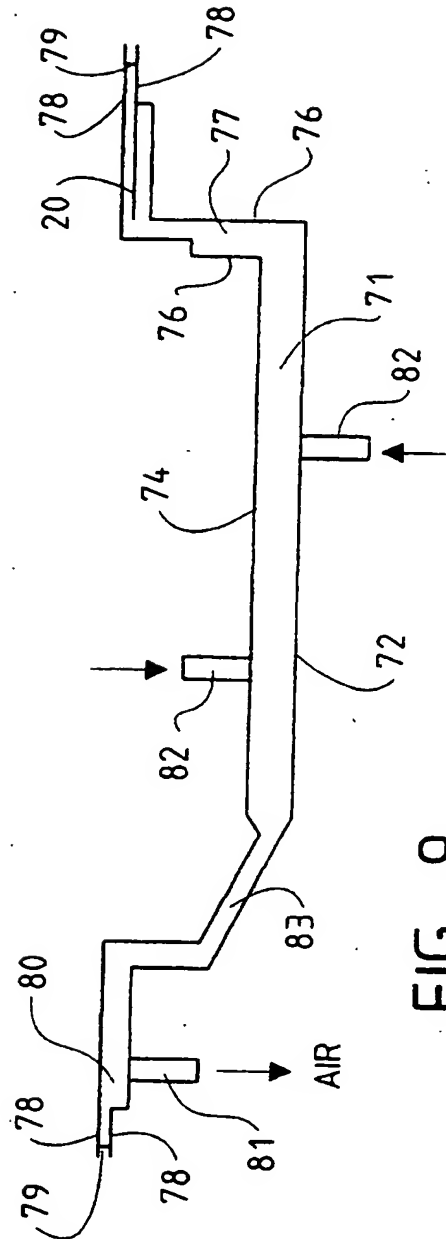


FIG. 9

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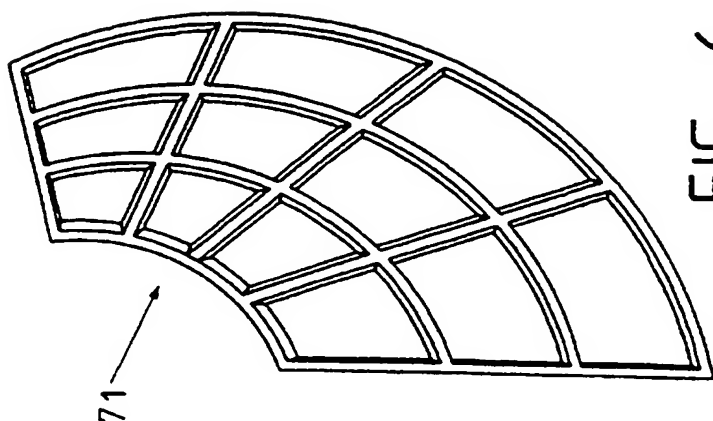


FIG. 6

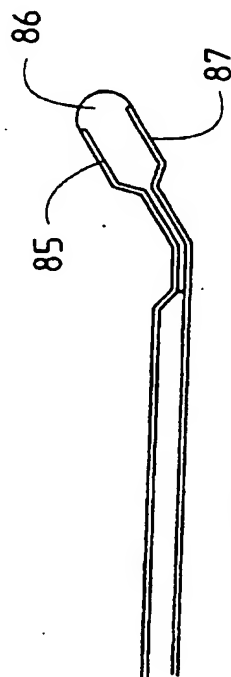


FIG. 8

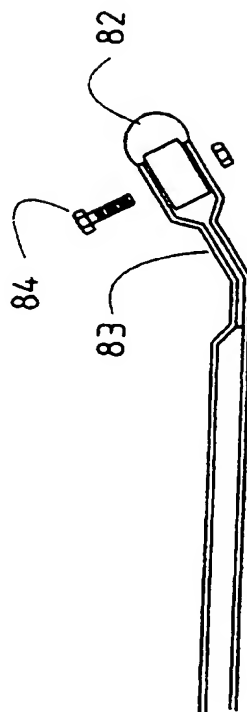


FIG. 7

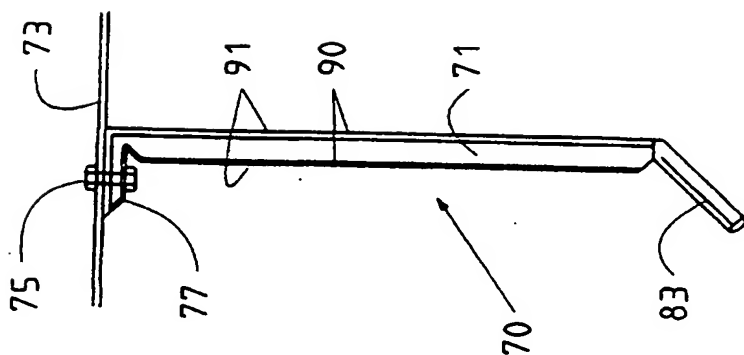


FIG. 5

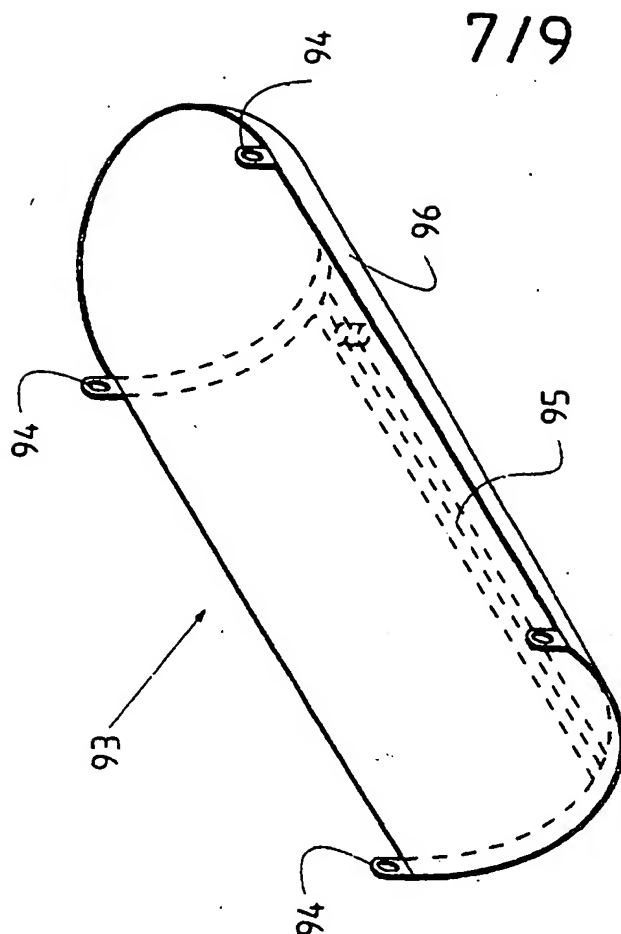


FIG. 11

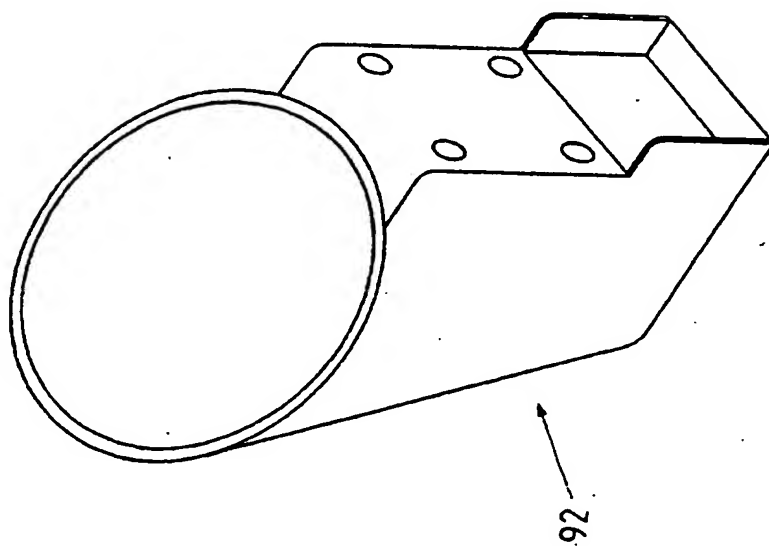


FIG. 10

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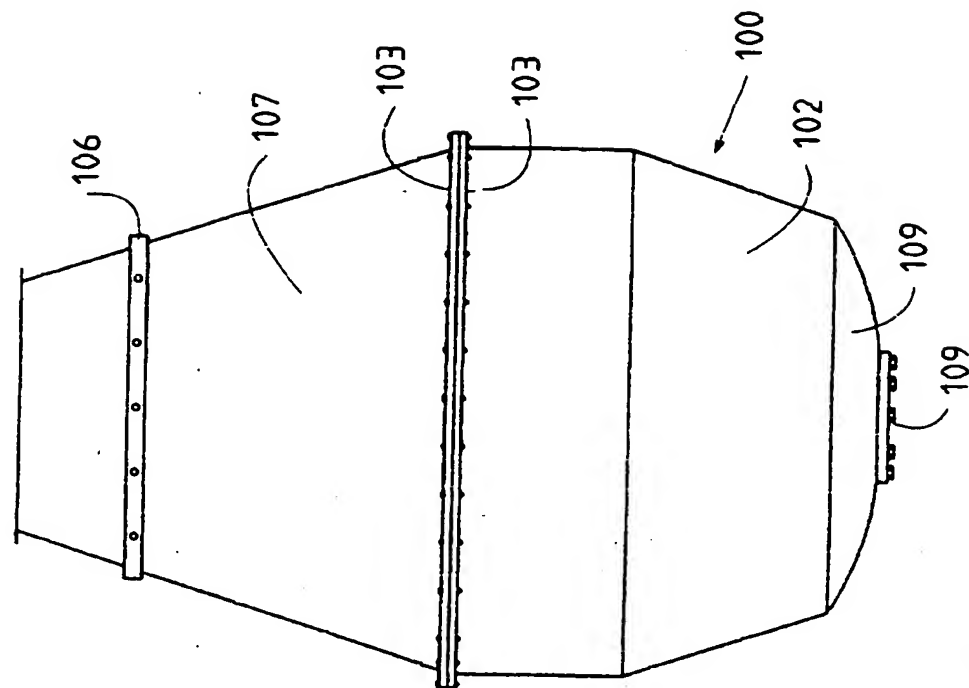


FIG. 12

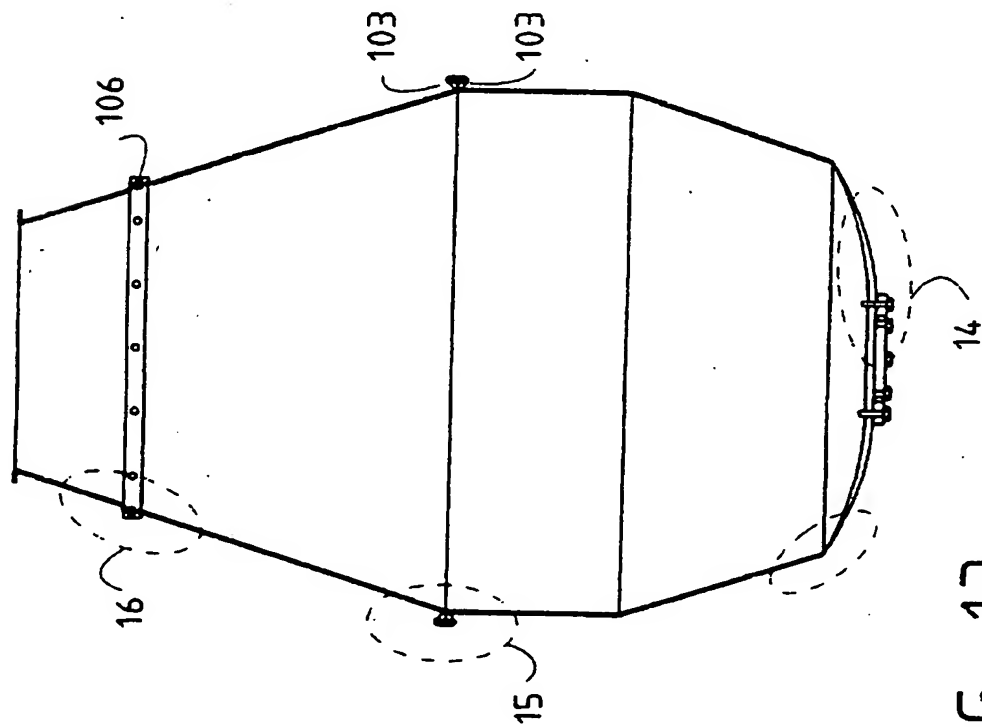


FIG. 13

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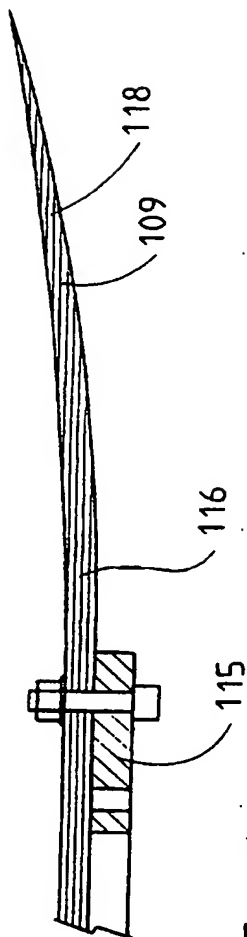


FIG. 14

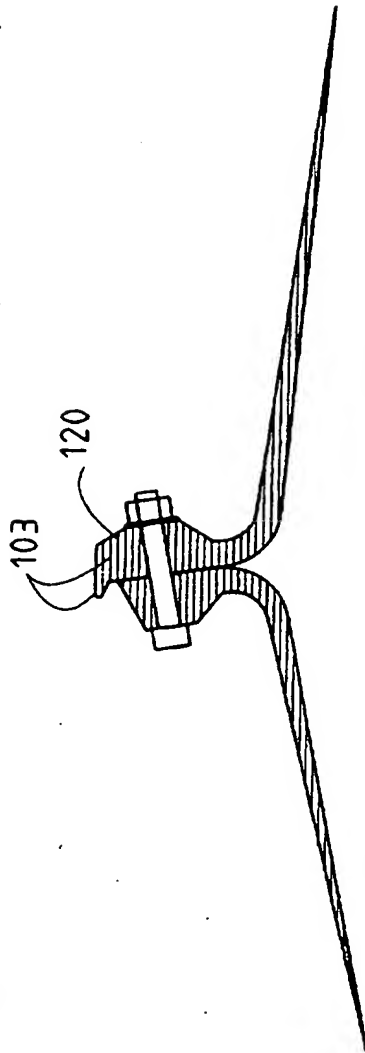


FIG. 15

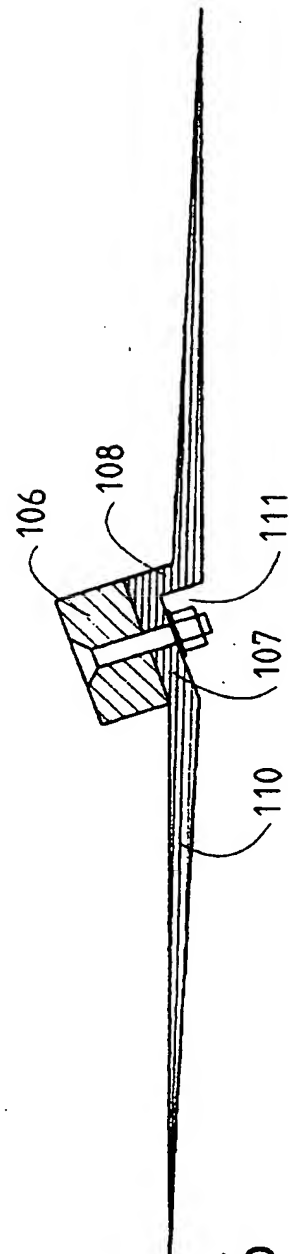


FIG. 16

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/AU 97/00143

A. CLASSIFICATION OF SUBJECT MATTER																						
Int Cl ⁶ : B28C 5/18, 5/20, 5/42; B01F 9/02; B05B 13/06																						
According to International Patent Classification (IPC) or to both national classification and IPC																						
B. FIELDS SEARCHED																						
Minimum documentation searched (classification system followed by classification symbols) IPC: B28C 5/18, 5/20, 5/42; B01F 9/02; B05B 13/06; B65D 8/04																						
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU: IPC as above																						
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPAT, JAPIO: (B05B 13/06 or B28C 5/- or B65D 8/04) and (plastic or polymer:) (B01F 7/- or 9/-) and (Stir: or helic: or helix) and (coat: or protect:)																						
C. DOCUMENTS CONSIDERED TO BE RELEVANT																						
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																				
X Y	DE 4010539 A (STETTER GmbH) 10 October 1991 Figures	1-3, 8-10 23																				
X Y	GB 956378 A (MARG MACHINENBAU GmbH) 29 April 1964 Page 3 lines 48-51, Figure 6	1 23																				
X Y	Patents Abstracts of Japan, JP 07-204483 A (TAIYO TOKUSHU YOSETSU KK) 8 August 1995	1 23																				
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex																						
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A"</td> <td>document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T"</td> <td>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E"</td> <td>earlier document but published on or after the international filing date</td> <td>"X"</td> <td>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L"</td> <td>document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y"</td> <td>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O"</td> <td>document referring to an oral disclosure, use, exhibition or other means</td> <td>"&"</td> <td>document member of the same patent family</td> </tr> <tr> <td>"P"</td> <td>document published prior to the international filing date but later than the priority date claimed</td> <td></td> <td></td> </tr> </table>			"A"	document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E"	earlier document but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family	"P"	document published prior to the international filing date but later than the priority date claimed		
"A"	document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention																			
"E"	earlier document but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone																			
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art																			
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family																			
"P"	document published prior to the international filing date but later than the priority date claimed																					
Date of the actual completion of the international search 3 June 1997		Date of mailing of the international search report 06 Jun 1997																				
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929		Authorized officer ROGER HOWE Telephone No.: (06) 283 2159																				

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/AU 97/00143

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5118198 A (WHITEMAN, Jr) 2 June 1992	
Y	Abstract	16
		23
X	US 3362642 A (FREEMAN et al.) 9 January 1968	
	Whole document	28
Y	US 5427449 A (CHRISTENSON et al.) 27 June 1995	
A	Abstract	23
		6, 7, 11
Y	EP 438852 A (McNEILUS TRUCK AND MANUFACTURING INC) 31 July 1991	
A	Abstract	23
		6, 7, 9-11

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00143

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/AU 97/00143

Box II continued

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are three inventions:

- 1 Claims 1-15, 23-27 directed to a mixing barrel assembly wherein the screw-flight has a resilient wear resistant coating along its free edge portion. It is considered that this coating comprises a first "special technical feature"
- 2 Claims 16-23 directed to a mixing barrel made of composite plastic material and of specific shape. It is considered that this use of plastic material comprises a second "special technical feature".
- 3 Claim 28-29 directed to a spray head having a controlled travel path relative to the surface to be coated. It is considered that this controlled path comprises a third "special technical feature".

Since the abovementioned groups of claims do not share a special technical feature, a "technical relationship" between the inventions, does not exist. Accordingly the as defined by PCT rule 13.2 international application does not relate to one invention or to a single inventive concept.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International Application No.
PCT/AU 97/00143

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	3362642	BE	696108	JP	48033047		
US	5427449	US	5378061				
EP	438852	AU	52918/90	CA	2013511	DE	69025159
		JP	3222702	US	5056924		
END OF ANNEX							